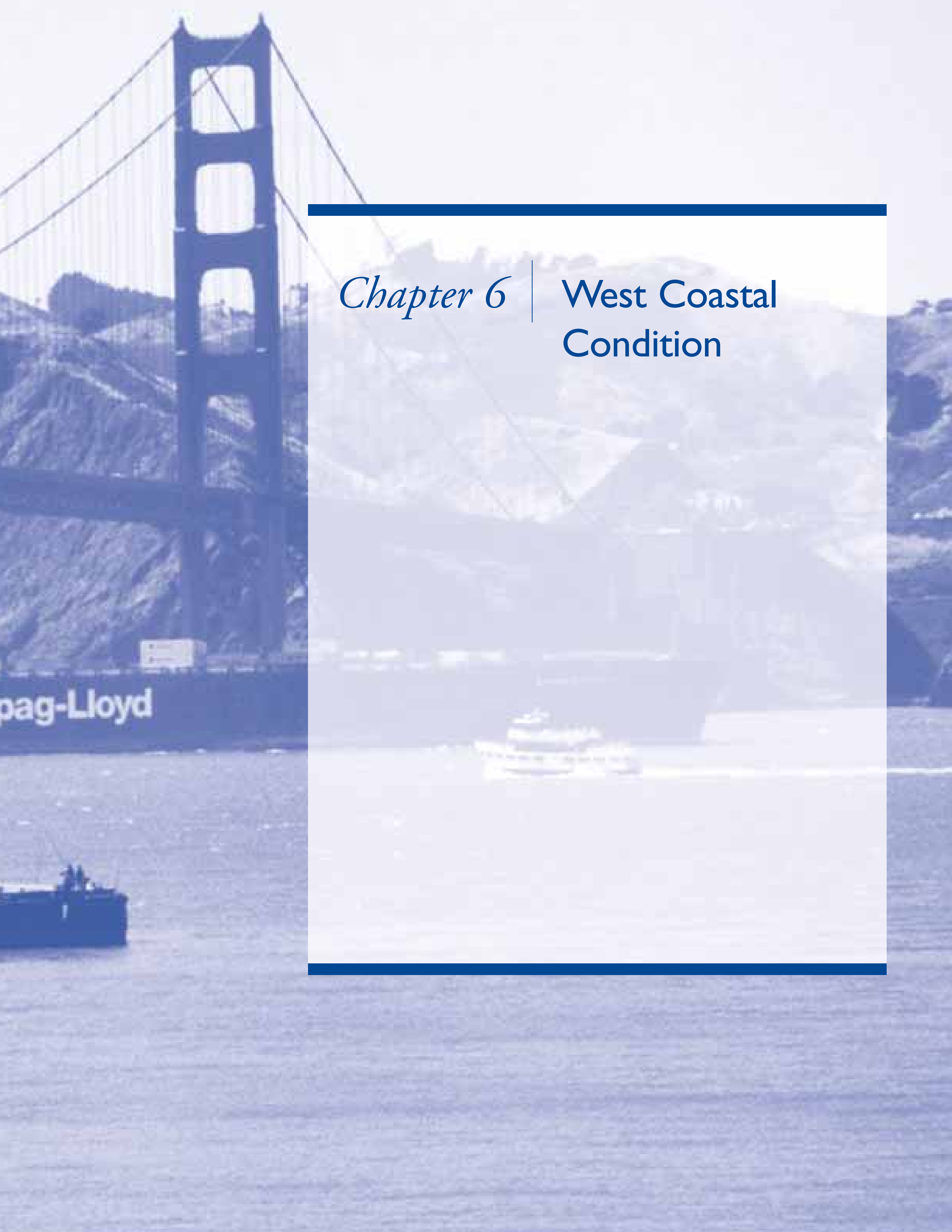
Chapter 6 West Coastal Condition



West Coastal Condition

Ecological conditions in West Coast estuaries are fair to poor (Figure 6-1). Based on the 1999–2000 NCA surveys, 14% of the estuarine area in the West Coast region is unimpaired for aquatic life and human uses; 17% is impaired for aquatic life use; and 27% is impaired for human use (Figure 6-2). An additional 59% is considered threatened for these uses (fair condition); however, these survey results do not include benthic community data from San Francisco Bay, Puget Sound, or the Columbia River, and the percentages might be revised after the inclusion of that information. The estuaries that were found to be threatened for aquatic life use had extensive areas with elevated phosphorus concentrations and decreased water clarity.

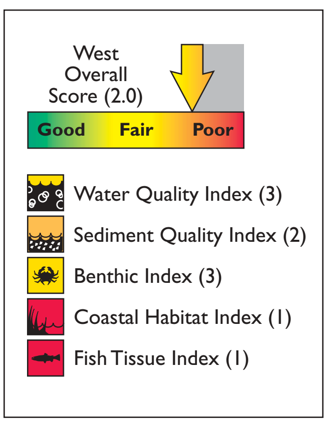


Figure 6-1. The overall condition of West Coast estuaries is fair. (This rating does not include benthic index or fish tissue contaminants information from the San Francisco Estuary, Columbia River, or Puget Sound system.)

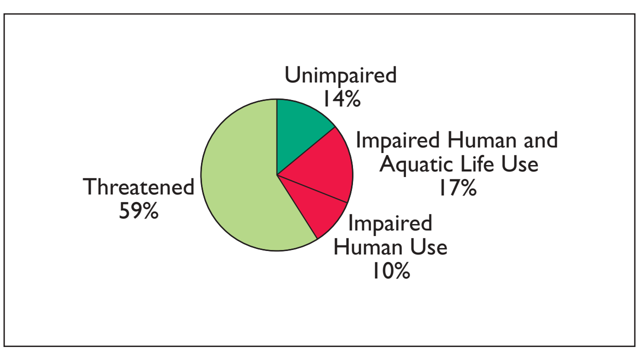
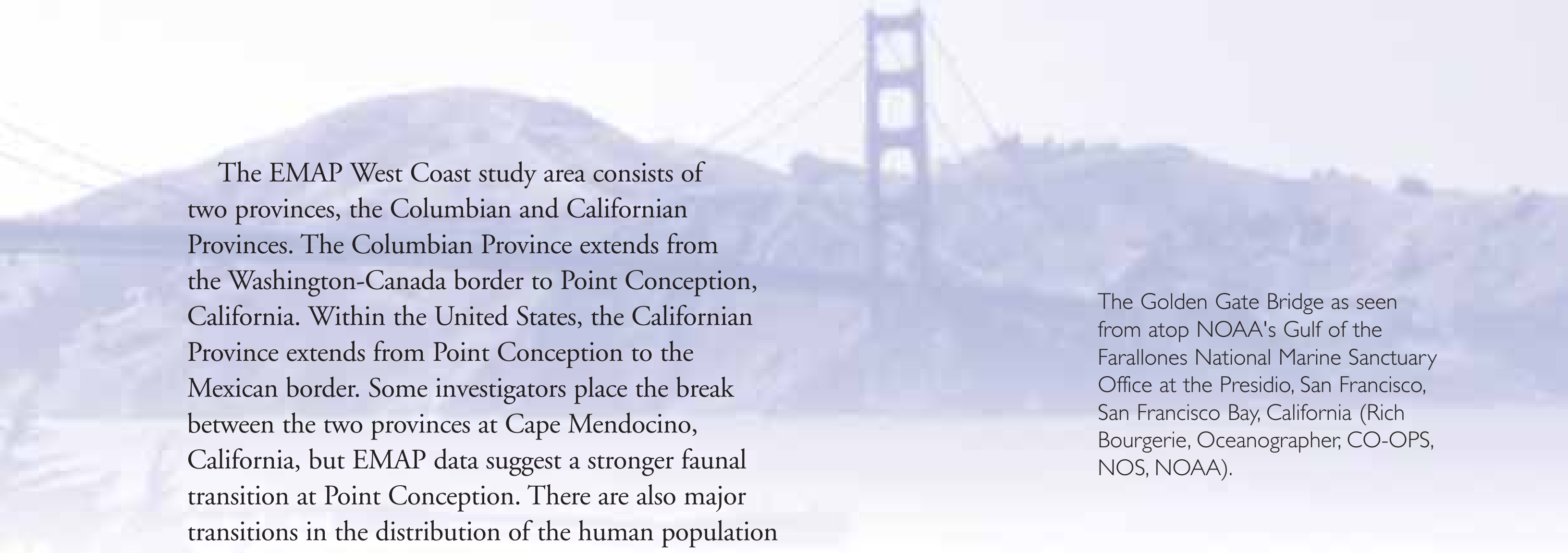


Figure 6-2. West Coast estuarine condition (U.S. EPA, NCA).

The estuaries of the West Coast of the United States represent a valuable resource that contributes to the local economies of the area and enhances the quality of life for those who work, live, and visit there. The population of 47 coastal and estuarine counties on the West Coast increased 13% between 1990 and 2000 to a total of 29.3 million (U.S. Census Bureau, 2001). Some counties adjacent to estuaries in the region (e.g., San Juan County, Washington, on Puget Sound) grew more than 40% over the 10-year period. Population growth rates for the counties bordering the greater Puget Sound region between 2000 and 2020 are projected to range between 16% and 54% (Puget Sound Water Quality Action Team, 2002). These growth rates suggest that human pressures on coastal resources will increase substantially in many areas of the West Coast.

The western coastline comprises more than 410 estuaries, bays, and subestuary systems associated with larger estuaries. Youngs Bay within the Columbia River and South Slough within Coos Bay are examples of subestuaries within larger estuarine systems. Such subestuaries share a number of characteristics with the larger estuarine system, such as climate and biogeographic province; however, they may differ from the larger estuarine system because of local hydrology, geomorphology, or pollutant inputs. The total area of the West Coast estuaries, bays, and subestuaries is 3,940 square miles, 61.5% of which is made up of the three large systems—the San Francisco Estuary, Columbia River, and Puget Sound system (including the Strait of Juan de Fuca). Subestuary systems associated with these large systems make up another 26.8% of the estuarine area. All the other West Coast estuaries combined equal only 11.7% of the total estuarine area. The range of estuary types on the West Coast is illustrated by the five order-of-magnitude range in size of the systems sampled by EMAP in 1999 and 2000—from 0.0237 square miles Yachats River, Oregon) to 2551 square miles (Puget Sound and Strait of Juan de Fuca).



The Golden Gate Bridge as seen from atop NOAA's Gulf of the Farallones National Marine Sanctuary Office at the Presidio, San Francisco, San Francisco Bay, California (Rich Bourgerie, Oceanographer, CO-OPS, NOS, NOAA).

The EMAP West Coast study area consists of two provinces, the Columbian and Californian Provinces. The Columbian Province extends from the Washington-Canada border to Point Conception, California. Within the United States, the Californian Province extends from Point Conception to the Mexican border. Some investigators place the break between the two provinces at Cape Mendocino, California, but EMAP data suggest a stronger faunal transition at Point Conception. There are also major transitions in the distribution of the human population along the West Coast. Major population centers occur in the Seattle-Tacoma area of Puget Sound, around the San Francisco Estuary, and generally around most of the estuaries of southern California. In contrast, the region of coastline north of the San Francisco Estuary through northern Puget Sound has a much lower population density.

Coastal Monitoring Data

In 1999, the Washington Department of Ecology (DOE), Oregon Department Environmental Quality, Moss Landing Marine Laboratories, San Francisco Estuary Institute, and the Southern California Coastal Water Research Project initiated a project to assess the condition of the approximately 400 estuaries, subestuaries, and tidal rivers along the West Coast (Washington, Oregon, and California). The assessment used a probabilistic design and, in 1999, sampled 210 locations in small estuarine systems (Figure 6-3) for dissolved oxygen, light penetration, sediment toxicity, sediment contaminants, tissue residues, fish community parameters, and benthic communities. In 2000, similar data were collected from 171 locations in Puget Sound, the San Francisco Estuary, and the lower Columbia River (Figure 6-3). In both Puget Sound and the San Francisco Estuary, data collection involved extensive collaboration between EPA's NCA and NOAA's NS&T programs.

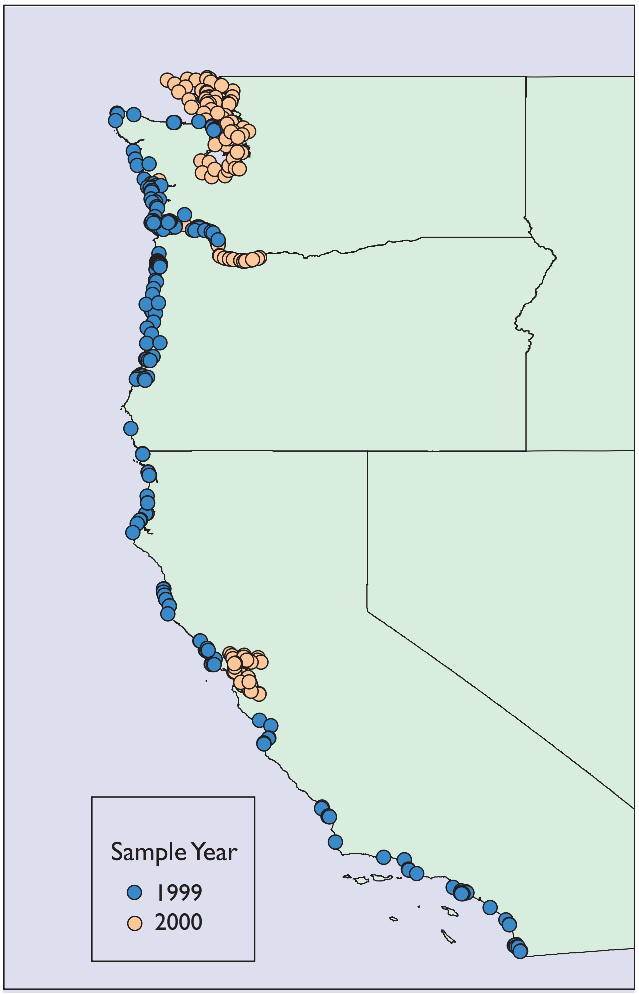


Figure 6-3. West Coast sampling stations for the 1999–2000 NCA survey (U.S. EPA, NCA).

Relatively few national programs have monitoring stations in West Coast estuaries. NOAA's National Estuarine Eutrophication Assessment (NOAA, 1998a) examined a number of eutrophication variables for West Coast estuaries through the use of a survey questionnaire. NOAA's NS&T Program collects data for several western locations (Long et al., 2000), but these sites are not representative of all West Coast estuaries. In addition, EMAP-like surveys have been completed in the Southern California Bight (SCCWRP, 1998). In comparison with these geographically focused studies, the Western EMAP sampled small western estuaries in 1999 and 2001, large estuaries in 2000, the intertidal areas of small and large estuaries in 2002, and the continental shelf in 2003. The data reported in this chapter include surveys of small and large estuaries from 1999 to 2000.

Water Quality Index

Water quality for West Coast estuaries, as measured by five indicators—surface DIN and DIP, chlorophyll *a*, water clarity, and bottom dissolved oxygen—is fair. Most West Coast estuaries (69%) received fair ratings for water quality, largely because of the levels of phosphorus measured. Three percent of estuaries on the West Coast have poor water quality (Figure 6-4). Estuaries with poor water quality were found primarily in California, as well as in both San Francisco Bay and its subestuaries and in other estuaries along the California coast. The only site outside California with poor water quality was south Hood Canal, Washington. Low ratings for the water quality index were driven primarily by poor conditions for phosphorus. The finding that 3% of the West Coast estuarine area has poor water quality should be considered preliminary because only DIP concentrations and water clarity were generally poor. However, most estuarine area in the West Coast has decreased water quality (72% of this area received a poor or fair rating).

The sampling conducted in the EPA NCA Program has been designed to estimate the percent of estuarine area (nationally or in a region or state) in varying conditions and is displayed as pie diagrams. Many of the figures in this report illustrate environmental measurements made at specific locations (colored dots on maps); however, these dots (color) represent the value of the indicator specifically at the time of sampling. Additional sampling may be required to define variability and to confirm impairment or the lack of impairment at specific locations.

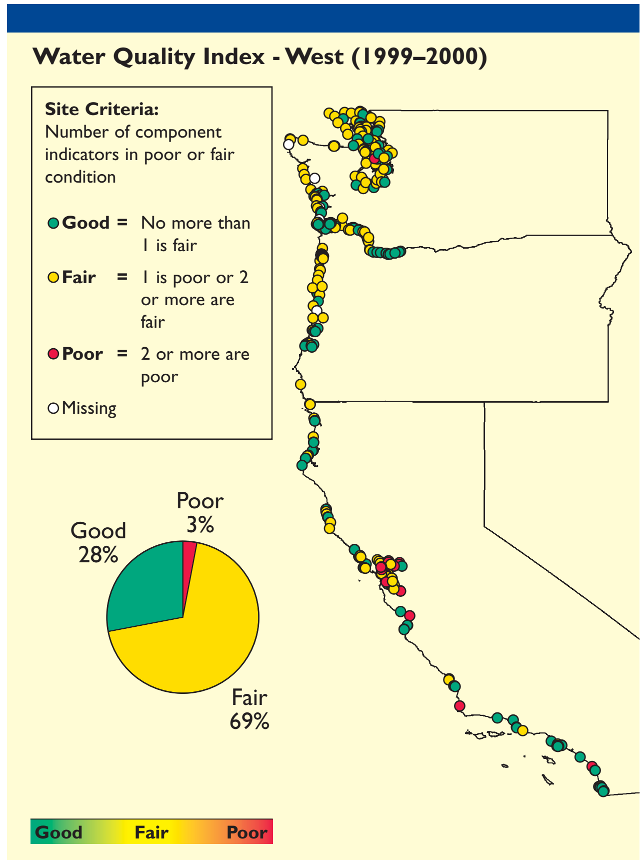


Figure 6-4. Water quality index data for West Coast estuaries (U.S. EPA/NCA).

Looking south at the base of Haystack Rock at Cannon Beach, Oregon (Carol Baldwin, NOAA OMAO).

Nutrients: Nitrogen and Phosphorous

DIN concentrations in West Coast estuaries are rated good. High concentrations of DIN in surface waters occurred in less than 1% of the estuarine area of the West Coast. All sites with high nitrogen were found along the central California coast (Figure 6-5). The threshold for a West Coast site to be rated poor for nitrogen was a concentration in excess of 1 mg/L, as compared with a threshold used by the NCA of 0.5 mg/L for most other regions of the United States. The level of 1 mg/L corresponds to the level used by the NOAA/EPA Team on Near Coastal Waters to indicate high nitrogen levels in its report on susceptibility of West Coast estuaries to nutrient discharges (1991). Along much of the West Coast, summer wind conditions result in an upwelling of nutrient-rich deep water that enters estuaries during flood tides (Landry et al., 1989) and constitutes a potentially important natural nutrient input for many of these West Coast estuaries.

DIP concentrations in West Coast estuaries are rated fair. Whereas high concentrations of DIN were not prevalent in West Coast surface waters, high concentrations of DIP occurred in 10% of surface waters of the estuarine area of the West Coast (Figure 6-6). Only 4% of sites received a rating of good for DIP, in contrast with nearly 93% of sites for DIN. The threshold for a West Coast site to be rated poor for phosphorus was a concentration in excess of 0.1 mg/L, as compared with a threshold used by the NCA of 0.05 mg/L for most other regions of the United States. The level of 0.1 mg/L corresponds to the level used to indicate high phosphorus levels in the report on susceptibility of West Coast estuaries to nutrient discharges conducted by the NOAA/EPA Team on Near Coastal Waters (1991). Sites with high phosphorus tended to be found throughout California, and particularly in the San Francisco Estuary. As with nitrogen, upwelling may be an important contributing factor to the high DIP concentrations on the West Coast during the summer.

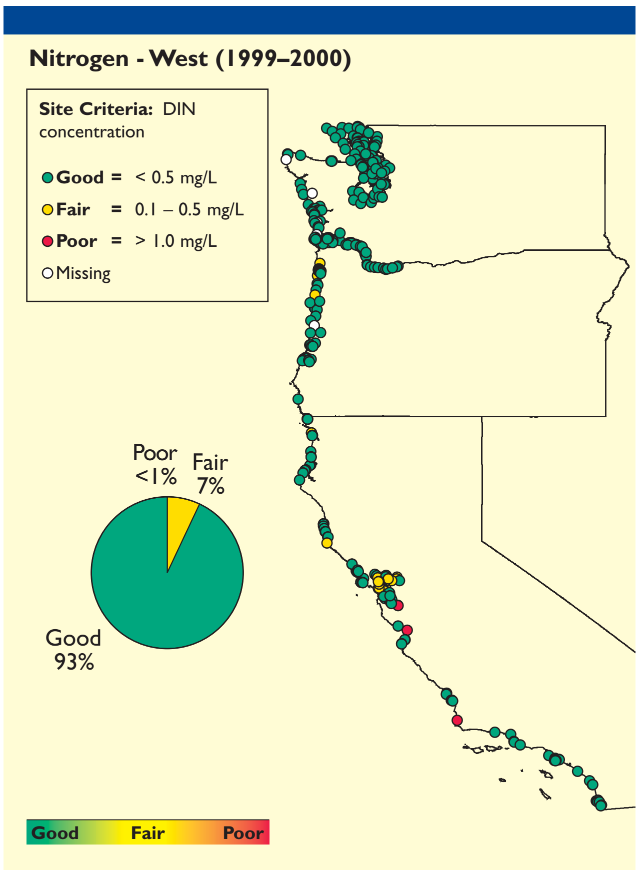


Figure 6-5. DIN concentration data for West Coast estuaries (U.S. EPA/NCA).

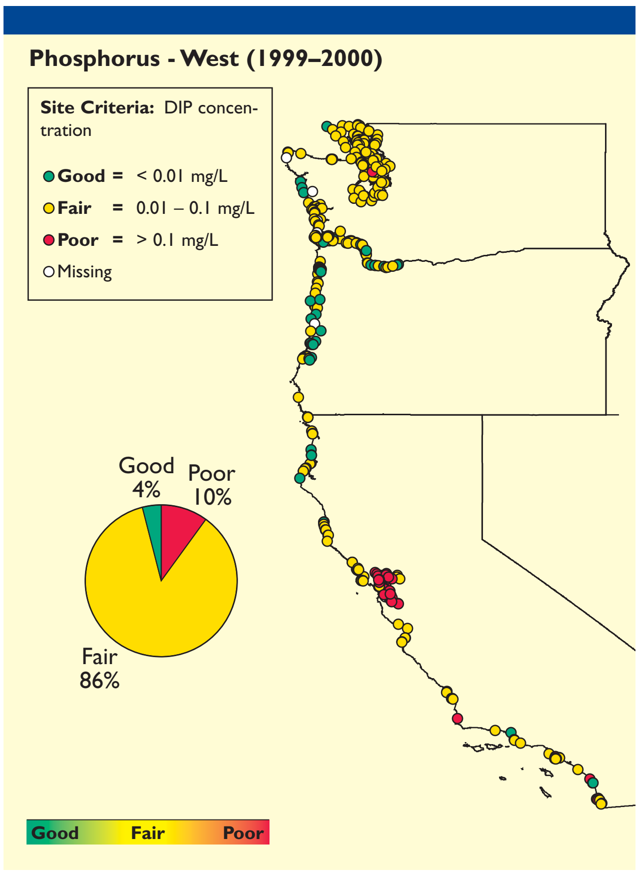
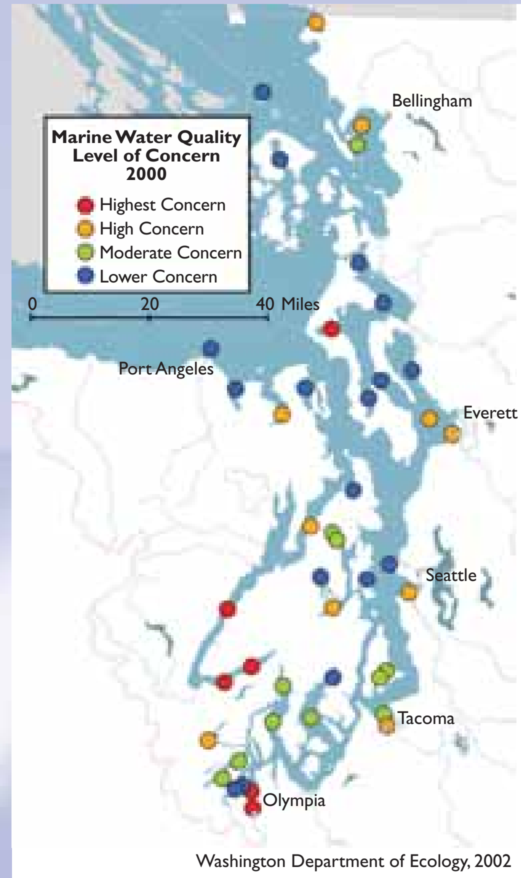


Figure 6-6. DIP concentration data for West Coast estuaries (U.S. EPA/NCA).

Marine Water Quality in Puget Sound

Puget Sound's marine waters provide essential habitat for organisms ranging from plankton to marine fish (including salmon) to marine mammals. Washington's DOE summarizes overall water quality based on the strength and persistence of layers, or stratification, in the water column; lack of nitrogen-containing nutrients for several months; low amounts of dissolved oxygen in the water; high ammonium concentrations; and high fecal coliform bacteria counts. These results are presented in terms of levels of overall water quality concern.



Marine water quality level of concern, 2000.

Components of Marine Water Quality

The following characteristics of marine waters are measured to determine water quality:

Fecal coliform bacteria—not agents of disease themselves, these bacteria indicate the presence of other disease-causing organisms from sewage, wildlife, or agricultural contamination.

Dissolved oxygen—low dissolved oxygen levels can be harmful to some marine life, such as fish.

DIN—some marine waters are susceptible to water quality problems when nutrients are added from wastewater or agricultural sources.

Ammonium—high concentrations can indicate sewage or agricultural contamination.

Stratification—when marine waters develop stable layers, pollutants and nutrients cannot be mixed, and some layers may develop water quality problems.

Status

Based on data from 1994 to 2000, the areas of greatest marine water quality concern in Puget Sound are Budd Inlet, southern Hood Canal, and Penn Cove on Whidbey Island. Concern at Budd Inlet is due to high fecal coliform and ammonium concentrations, strong and persistent stratification, depleted oxygen levels, and low nutrients. Nutrient input to Budd Inlet decreased in the late 1990s as the regional wastewater treatment plant incorporated nitrogen removal. Southern Hood Canal and Penn Cove concerns include very low dissolved oxygen concentrations and sensitivity to additional nutrient loadings. The DOE generally classified sampling stations near urban areas or in areas with reduced levels of tidal flushing as areas of high concern. For more information, visit http://nsandt.noaa.gov/index_bioeffect.htm.

Chlorophyll *a*

Chlorophyll *a* concentrations in West Coast estuaries are rated good. Less than 1% of the estuarine area on the West Coast is rated poor for chlorophyll *a* (Figure 6-7). Concentrations greater than 20 µg/L occurred in only three locations, including two sites in California and one site in Washington (south Hood Canal). Although almost no areas within West Coast estuaries showed high concentrations of water column chlorophyll *a*, this may not indicate low land-based loading of nitrogen and phosphorus. Many West Coast estuaries have large intertidal areas, so nutrient utilization by benthic algae may be of greater importance than nutrient uptake by phytoplankton. Results of 2002 surveys of these intertidal areas, using benthic algal coverage as an indicator of conversion of nutrient loadings to chlorophyll, are not yet available to address this issue.

Water Clarity

Water clarity in West Coast estuaries is rated poor. Water clarity was rated poor at a sample site if light penetration at 1 meter was less than 10% of surface illumination. Approximately 36% of estuarine area in the West Coast received less than 10% of surface illumination at 1 meter (Figure 6-8). This finding is consistent with that made by the NOAA Eutrophication Survey (NOAA, 1998a), which reported high turbidity in 20 of the 38 West Coast estuaries surveyed. This number represents water clarity only in late summer and does not represent high-flow wet season conditions in the winter. The large tidal amplitude found in many estuaries along the West Coast may tend to contribute to higher levels of turbidity in the water column. Stations with limited water clarity were broadly distributed across the West Coast states (Figure 6-8).

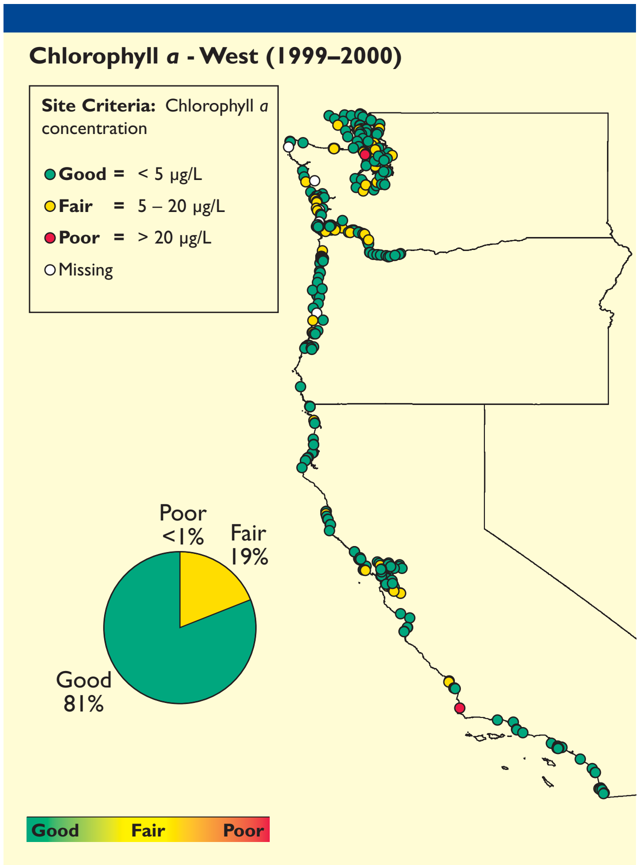


Figure 6-7. Chlorophyll *a* concentration data for West Coast estuaries (U.S. EPA/NCA).

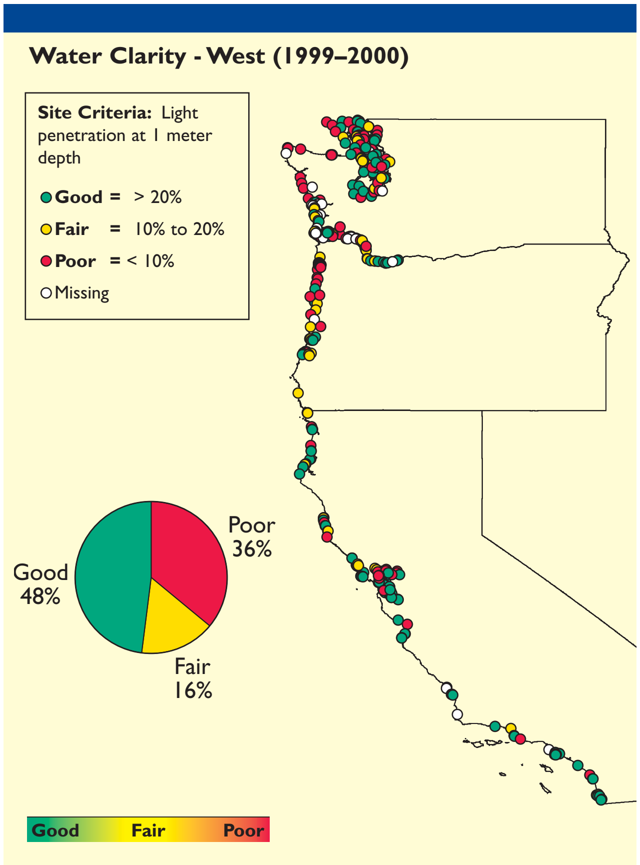


Figure 6-8. Water clarity condition for West Coast estuaries (U.S. EPA/NCA).

EMAP and NOAA Assess Condition of the Continental Shelf of the U.S. West Coast

EPA's EMAP, in cooperation with NOAA, conducted an assessment of soft sediment habitat conditions on the continental shelf of the West Coast in 2003. The assessment design included a survey of bottom community conditions for the five NOAA National Marine Sanctuaries (Olympic, Cordell Banks, Gulf of Farallones, Monterey Bay, and Channel Islands), as compared to non-sanctuary areas of the West Coast shelf.

NOAA research vessel *McArthur II* (CDR Michele G. Bullock/NOAA).

Principally funded by the EPA, Office of Research and Development, the project involved the cooperation of numerous organizations. NOAA was a major partner in the study, contributing ship time on the research vessel *McArthur II* to the assessment effort. The Northwest Fisheries Science Center of NOAA provided field support and analysis of fish disease conditions and cooperated with EPA to provide fish for contaminant analysis from samples collected under the NOAA West Coast Slope Survey Fisheries Assessment Program. State partners included the Washington DOE, Oregon Department of Environmental Quality, and the Southern California Coastal Water Resources Project (SCCWRP). Moss Landing Marine Laboratories, under contract to SCCWRP, provided field crews for the collection of samples in California coastal waters .

The 2003 West Coast shelf assessment included soft sediment benthic resources of the continental shelf from the Strait of Juan de Fuca in Washington to the Mexican border. A total of 150 stations were sampled at a depth range between 30 and 120 feet. Each state had a minimum of 50 stations. In Washington, the 50 stations were split into two groups consisting of 30 stations randomly selected within the Olympic NMS and 20 stations in the remainder of the shelf waters. Similarly, in California, 50 stations were split into two groups consisting of 30 stations randomly selected within the Cordell Banks, Gulf of Farallones, Monterey Bay, and Channel Islands National Marine Sanctuaries, and 20 stations distributed on the shelf in the remainder of California, north of Point Conception. The shelf region between Point Conception and the Mexican border was sampled for most of the same condition indicators during summer 2003 as part of the Bight 2003 study by a consortium of agencies led by SCCWRP. The Bight 2003 data will be integrated with the EMAP data to provide an overall assessment of the condition of the continental shelf for California and the West Coast.

Environmental condition indicators that were sampled in this study (Table 1) included

(1) general habitat condition indicators
(2) water quality indicators
(3) benthic condition indicators
(4) exposure indicators.

Table 1. Environmental Indicators for the EMAP-West Coast Assessment of Shelf Benthic Condition in 2003 (U.S. EPA/NCA).

Habitat Condition Indicators	**Benthic Condition Indicators**
Salinity	Infaunal species composition
Water depth	Infaunal abundance
pH	Infaunal species richness and diversity
Water temperature	External diseases in fish
Total suspended solids	Presence of nonindigenous species
Transmittance	
Sediment grain size	
Percent TOC in sediments	
Sediment color/odor	
Presence of trash/marine debris	
Water Quality Indicators	**Exposure Indicators**
Chlorophyll *a* concentration	Dissolved oxygen concentration
Nutrient concentrations (nitrates, nitrites, ammonia, and phosphate)	Sediment contaminants
	Fish tissue contaminants

Dissolved Oxygen

Dissolved oxygen conditions in West Coast estuaries are good. NCA estimates for West Coast estuaries show that less than 1% of the bottom waters exhibit hypoxia (<2 mg/L dissolved oxygen) in late summer (Figure 6-9). Out of the total of 371 stations sampled, dissolved oxygen was measured below 2.0 mg/L at only two station locations. Both of these stations were located in subestuaries of Puget Sound (Dabob Bay and south Hood Canal), which are deeper, fjord-like systems and may often have low dissolved oxygen in bottom waters. In addition, 25% of estuarine bottom waters were found to be in fair condition, with dissolved oxygen concentrations between 2 and 5 mg/L. The Puget Sound Water Quality Action Team (2002) identified south Hood Canal as an AOC for water quality because it may be particularly sensitive to increased nutrient loadings. Although conditions in the West Coast region appear to be generally good for dissolved oxygen, measured values reflect daytime conditions, and some areas may still experience hypoxic conditions at night.

Sediment Quality Index

The overall condition of West Coast estuarine sediment is fair to poor, with 14% of the area exceeding thresholds for sediment toxicity, sediment contaminants, or sediment TOC (Figure 6-10). This estimate of fair sediment condition reflects to a large extent the metal concentrations in the San Francisco Estuary and the metal and organic concentrations in the harbors and bays within the Puget Sound system (e.g., Duwamish River, Commencement Bay). Amphipod toxicity at stations within Puget Sound, the Columbia River, and Willapa Bay was the second most important contributor to the areal estimate of poor condition. Several other areas had either elevated sediment concentrations of contaminants or high sediment toxicity (e.g., Smith River in northern California, Los Angeles Harbor), but these areas constituted a relatively small areal percentage of the West Coast estuaries.

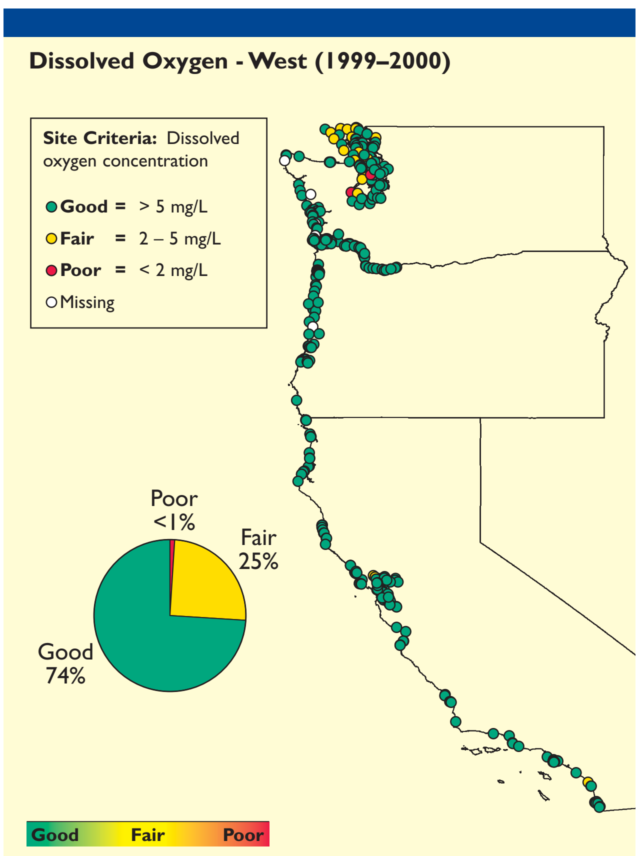


Figure 6-9. Dissolved oxygen concentration data for West Coast estuaries (U.S. EPA/NCA).

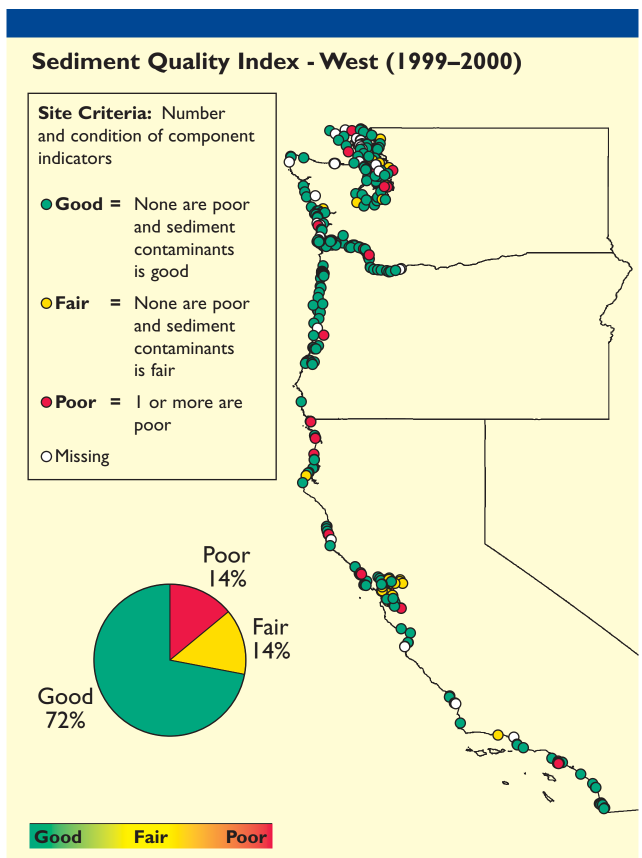


Figure 6-10. Sediment quality index data for West Coast estuaries (U.S. EPA/NCA).

Sediment Toxicity

Sediment toxicity for West Coast estuaries is rated poor. Sediment toxicity was determined using a static 10-day acute toxicity test with the amphipods *Ampelisca abdita* in marine or brackish waters or *Hyalella azteca* in freshwater portions of the Columbia River. Sediment was deemed toxic if the amphipods had less than an 80% control-corrected mean survival rate. Sediments in 17% of the estuarine area of the West Coast were toxic to amphipods (Figure 6-11). These toxic sediments were located largely in northern and central Puget Sound in Washington, in the Columbia River (Washington-Oregon), and in Los Angeles Harbor and several small river systems (e.g., Smith River, Klamath River, Little River) in northern California. Toxic sediments in Puget Sound were contaminated with DDT and metals and, in some cases, also exceeded ERLs for PAHs or PCBs. Sediments found in several northern California small river estuaries exceeded ERM or ERL levels for chromium, and sediments in the lower Columbia River (Grays Bay) exceeded ERLs for arsenic, copper, and chromium. One highly contaminated station in Los Angeles Harbor had 0% *Ampelisca* survival and exceeded 17 ERLs and 7 ERMs for metals, PAHs, and PCBs. Several stations in the Columbia River, Siuslaw River (Oregon), and Willapa Bay (Washington) were uncontaminated with the measured analytes, but had *Ampelisca* or *Hyalella* survival rates below 80%. These stations had very low TOC (0 to 0.1%) and percent fines (0 to 1.0%), which may have inhibited tube formation and survival in *Ampelisca* (U.S. EPA, 1994). For *Hyalella*, however, there is no known effect of grain size or TOC on survival (ASTM, 1995).

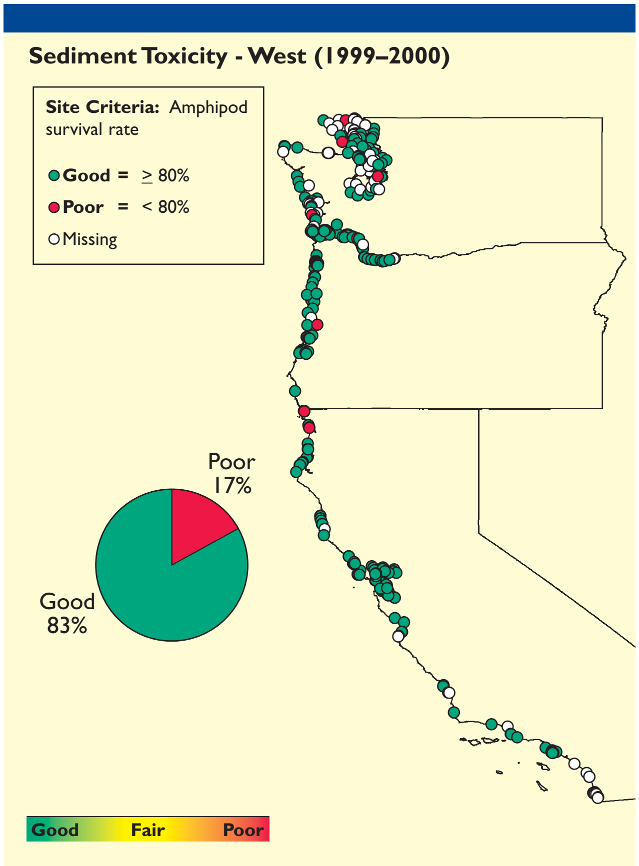
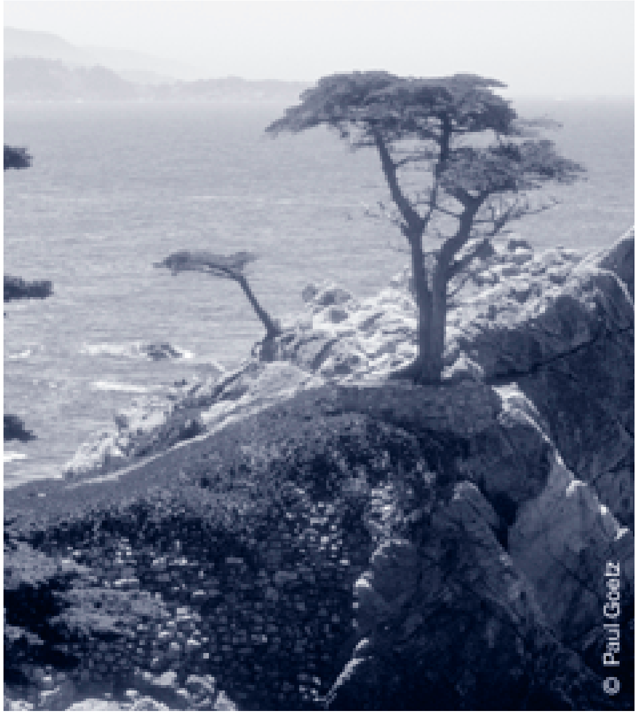


Figure 6-11. Sediment toxicity data for West Coast estuaries (U.S. EPA/NCA).



The rugged California coast is dotted with an abundance of small coves (Paul Goetz).

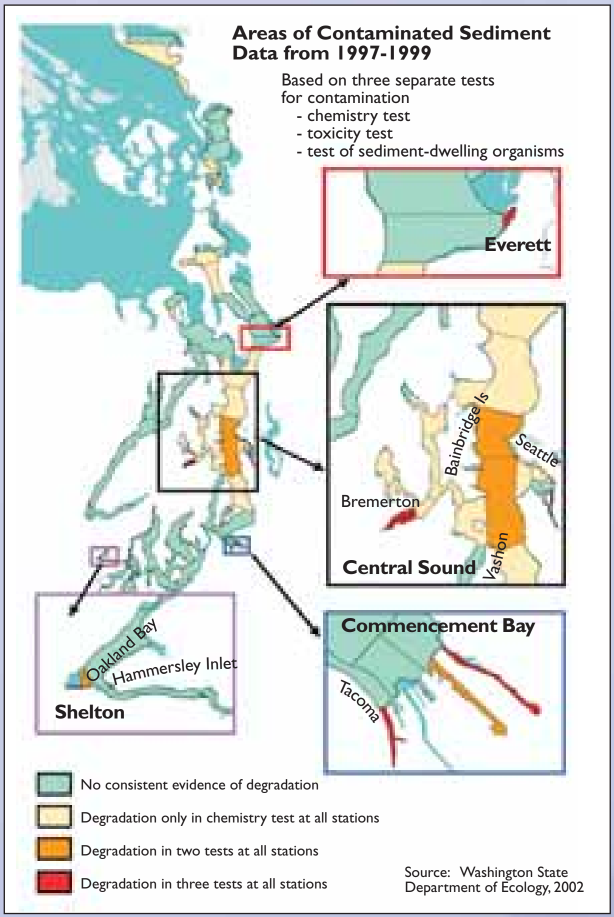
Sediment Quality and Extent of Sediment Contamination in Puget Sound

A cooperative effort to examine the spatial distributions of sediment toxicity in Puget Sound was recently completed by the Washington DOE and NOAA's National Centers for Coastal Ocean Science. Environmental contaminants associated with sediments represent a potential source of toxicity to organisms living in or on the sediments, and through the food chain, to higher trophic level species. These contaminants enter estuarine waters through runoff, freshwater inflow, industrial and municipal discharges, and atmospheric deposition. Once bound to particulate materials in the water column, such contaminants can settle out and become incorporated into surficial sediments.

The overall goal of the 3-year project was to quantify the percentage of significantly degraded sediment quality in Puget Sound. A total of 300 sediment samples were collected using a stratified random sampling design. A triad assessment of chemical contamination, toxicity, and benthic infauna structure was conducted to develop a spatial characterization of the 912-square-mile Puget Sound study area. Sediments were analyzed for 158 contaminants (including trace metals, pesticides, and hydrocarbons) and sediment parameters, most of which are analyzed in NOAA's NS&T Program. Toxicity tests included amphipod survival in bulk sediments, sea urchin fertilization success in pore waters, and microbial bioluminescence activity (Microtox™) in organic extracts of sediment. Organisms inhabiting the sediments were enumerated and identified to the species level.

Chemical concentrations above sediment quality guidelines (SQGs) were found in 1.3% (NOAA guidelines) to 34% (Washington State standards) of the Puget Sound study area. Only 1 in 300 samples resulted in acute toxicity in the amphipod survival test, representing an area of less than 0.1% of the total study area. In the other toxicity tests, significant results were recorded in 1 to 4% of the study area. In general, the spatial extent of toxicity found in Puget Sound was lower than results typically found in other estuarine systems in the United States.

Based on the triad of sediment quality, approximately 39 samples, or 1% of the area surveyed, displayed chemical contamination above an SQG, significant toxicity in any one of the three toxicity tests, and altered benthic infaunal communities. These samples were collected from Everett Harbor, the lower Duwamish River, Sinclair Inlet, Commencement Bay waterways, Olympia Harbor, and along Seattle's waterfront. In contrast, 81 sediment samples, or 42% of the study area, had uncontaminated sediments that were nontoxic and contained diverse and abundant benthos. These areas were typically in deep basins or shallow bays near undeveloped lands. Results of the study did show, however, that 180 samples, or approximately 57% of the study area in Puget Sound, had results that were termed intermediate (i.e., one or two of the three triad parameters were affected), indicating a need for continued monitoring of these areas to assess changes in sediment quality over time.



Sediment Contaminants

To assess the degree of sediment contamination in West Coast estuaries, the sediment concentrations of contaminants were compared with both the ERM and ERL guidelines (Long et al., 1995) (Figure 6-12). Sites with values exceeding an ERM for any pollutant were classified as having poor condition. The analysis of the West Coast estuaries excluded nickel and a PAH, phenanthrene. Phenanthrene was excluded because values were not available from all three states. Nickel was excluded because the ERM value has a low reliability for West Coast conditions where high natural crustal concentrations of nickel exist (Long et al., 1995). Because of its unreliability, nickel was also excluded from a recent evaluation of sediment quality in southern Puget Sound (Long et al., 2000). Additionally, a study of metal concentrations in cores on the West Coast determined an historical background concentration of nickel in the range of 35–70 ppm (Lauenstein et al., 2000), which brackets the value of the ERM (51.6 ppm). Some researchers have also suggested that West Coast crustal concentrations for mercury may be naturally elevated; however, no conclusive evidence is available to support this suggestion. Therefore, mercury data were not excluded from this assessment.

Sediment Contaminant Criteria (Long et al., 1995)

ERM (Effects Range Median)—Determined for each chemical as the 50th percentile (median) in a database of ascending concentrations associated with adverse biological effects.

ERL (Effects Range Low)—Determined values for each chemical as the 10th percentile in a database of ascending concentrations associated with adverse biological effects.

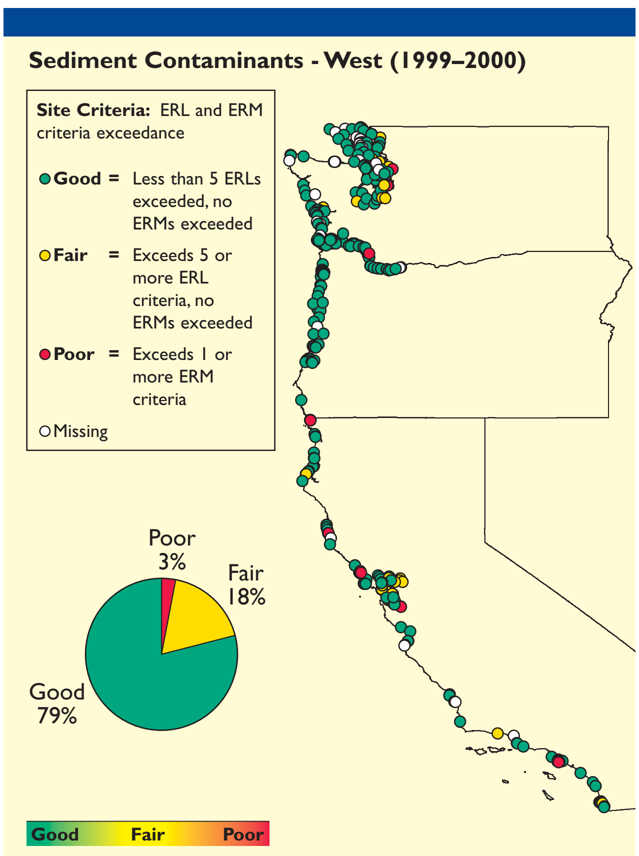


Figure 6-12. Sediment contaminants data for West Coast estuaries (U.S. EPA/NCA).

Excluding nickel, sediment concentrations exceeded their respective ERM values at 24 stations, representing 3% of the estuarine area. Twenty of these sites were located in California, 4 in Washington, and none in Oregon. In California, all the concentrations that exceeded the ERMs north of San Luis Obispo Bay, including the small northern California rivers and the San Francisco Estuary, were due to chromium, mercury, or copper. In Southern California, the exceedances were due to DDT, with the exception of the Los Angeles Harbor, which had high concentrations of several metals and PAHs. In Washington, three of the sediment concentrations that exceeded the ERMs occurred in harbors and bays within the Puget Sound system; one was in the Columbia River. All of these exceedances were due to either PAHs or PCBs.

Any site that had five or more compounds that exceeded their ERL values was classified as having fair condition. As with the ERMs, nickel was excluded from the analysis. To ensure that the analysis was not biased by PAHs, only one exceedance was counted if a site exceeded the ERL for LMW PAHs, HMW PAHs, or total PAHs. A total of 62 stations had five or more pollutants exceeding the ERL value, of which 12 also exceeded one or more ERMs. The 62 sites represent 21% (ERM exceedance = 3% and 5 ERL exceedances = 18%) of the area of the West Coast estuaries. Most of these sites (45) occurred in California, 17 sites occurred in Washington, and none occurred in Oregon. Of the California sites, 37 were located in the San Francisco Estuary. Six of the remaining California sites were in harbors or bays in southern California, and the two remaining sites were in northern California river-mouth estuaries. In Washington, 18 of the 20 sites exceeding these thresholds were located within the subestuaries (e.g., Everett Harbor, Elliott Bay) within the Puget Sound system.

To evaluate the relative contributions of different types of pollutants, the number of individual ERL exceedances was counted by pollutant class. Twenty-four ERLs were evaluated at each site (8 metals, total PCBs, 4,4'-DDE, total DDT, 12 individual PAHs, and total/LMW/HMW PAHs). Metals were the major contributor to sediment contamination in the San Francisco Estuary; about two-thirds of the individual ERL exceedances resulted from arsenic, chromium, copper, mercury, and zinc. Organic contaminants were relatively more important in the Puget Sound system. Total DDT exceeded ERL values at every station in Puget Sound, as well as at every station within the harbors and bays within the Puget Sound system. Combined, PAHs, DDTs, and PCBs contributed about 60% of the total ERL exceedances in the Puget Sound system, versus about 40% for the metals. The metals with the greatest number of exceedances (excluding nickel) in the Puget Sound system were arsenic, chromium, and copper.

Sediment Total Organic Carbon

Another measure of sediment condition is the percent TOC: values exceeding 5% ranked poor, values between 2% and 5% ranked fair, and values less than 2% ranked good. Using these criteria, two sites representing just 0.01% of the area of the West Coast estuaries were ranked poor (Figure 6-13). One of these sites, the Big Lagoon, borders the Redwood National Forest in northern California. This lagoon is periodically closed to the ocean by the natural movement of dune sands, so it is likely that the high organic content results from the natural trapping of terrestrial and wetland plant debris rather than from anthropogenic inputs. The other site that was ranked poor was in the Los Angeles Harbor, and the high organic content at this site may well represent anthropogenic inputs. Another 29 sites (7 sites in California, 6 in Oregon, and 16 in Washington) were ranked fair. In total, these sites represent 11% of the estuarine area of the West Coast. At several of these sites, there are no obvious anthropogenic inputs of organic matter (e.g., Raft River, Washington), and the elevated TOC levels may reflect natural conditions. In other cases (e.g., ports and harbors), the elevated levels may be indicative of anthropogenic inputs.

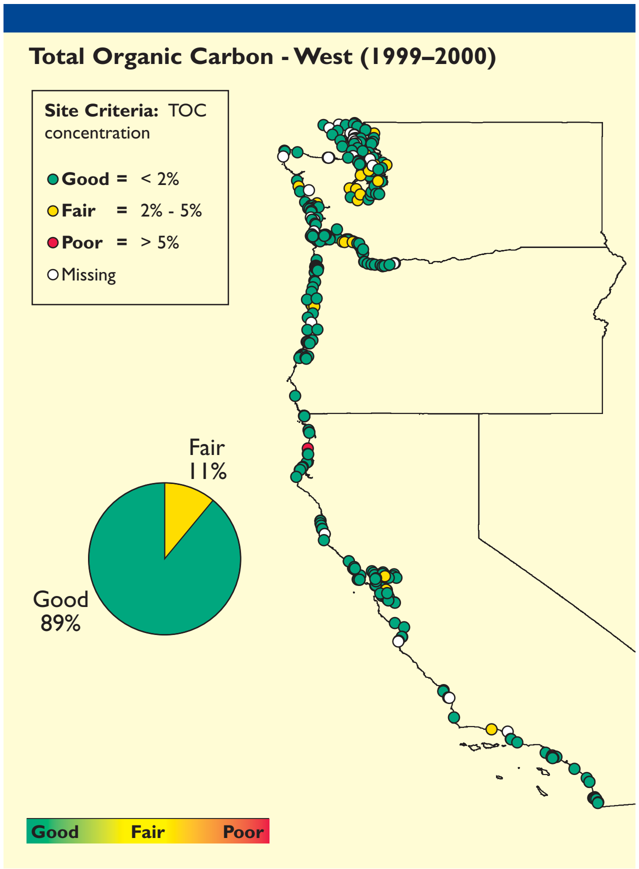
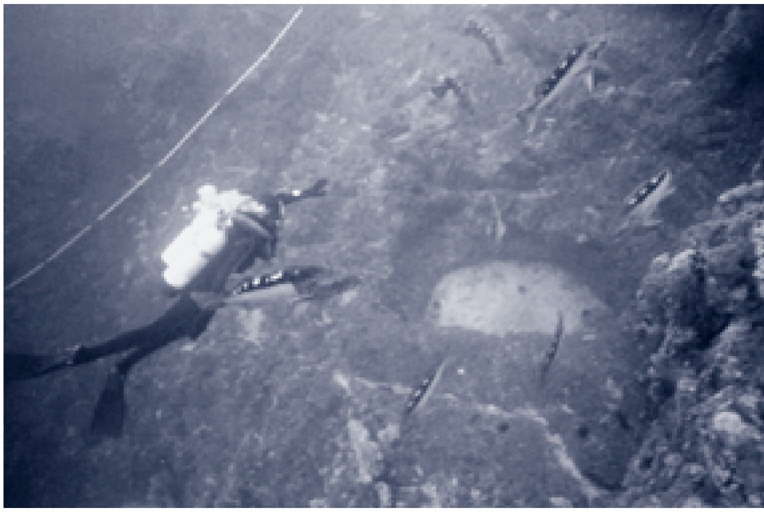


Figure 6-13. Sediment TOC data for West Coast estuaries (U.S. EPA/NCA).



A diver from Cordell Bank Expeditions discovers a small sediment pocket on the bank (Cordell Bank Expeditions).

Benthic Index

Sediment condition in West Coast estuaries as measured by the benthic index is fair. Although several efforts are under way and indices of benthic community condition have been developed for regions of the West Coast (e.g., Smith et al., 1998), there is currently no single benthic community index applicable for the entire West Coast. In lieu of a West Coast benthic index, the deviation of species richness from an estimate of expected species richness was used as an approximate indicator of the condition of the benthic community. The $\log_{10}$ transformed number of species per 0.1 m^2 grab sample was regressed on bottom salinity. The analysis was limited to the 1999 data because the 2000 benthic community data have not received final quality assurance/quality control checks. Therefore, areal estimates of affected benthic communities only apply to the small West Coast estuaries and not to the San Francisco Estuary, Puget Sound, or the main stem of the Columbia River. The benthic condition of any station with fewer species than 75% of the lower 95% confidence limit of the mean from the regression was ranked poor (Figure 6-14).

This approach requires that species richness be predicted from salinity. A significant linear regression between log species richness and salinity was found, although it was not strong ($r^2 = 0.43$, $p < 0.01$). Results of the regression indicated that 26 sites, representing 13% of the area of the West Coast estuaries, had a species richness of less than 75% of the lower 95% confidence limit. Sites with lower diversity were relatively evenly distributed across the three states, with 9 sites in California, 12 in Oregon, and 5 in Washington.

Results should be interpreted cautiously because there was only moderate concordance between lower species richness and indices of water quality or sediment quality, the components that comprise these indices, or individual contaminant ERLs (Figure 6-15). Only 3 of the 26 sites low in species richness occurred at stations

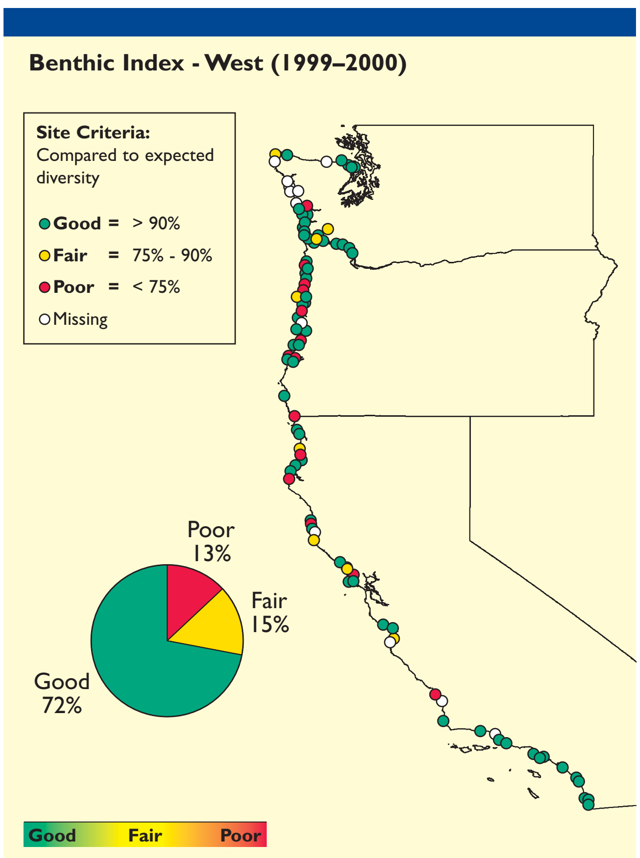


Figure 6-14. Benthic index data for West Coast estuaries (the San Francisco Estuary, Columbia River, and Puget Sound system were not included in the assessment) (U.S. EPA/NCA).

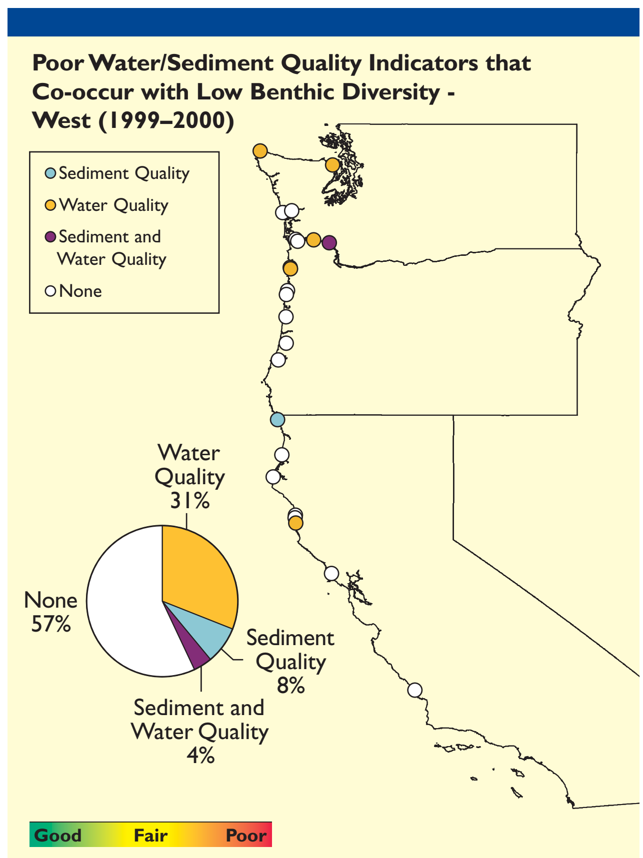


Figure 6-15. Indicators of poor water and sediment quality that co-occur with poor benthic condition in West Coast estuaries (U.S. EPA/NCA).

ranked poor for sediment contamination, high TOC concentrations, or amphipod toxicity. There was higher concordance of reduced diversity with indicators of water quality; only 9 of the 26 sites with reduced species richness occurred at a site ranked poor by the water quality index or its individual components. One site with low species richness also had poor ratings for sediment contamination and water quality. Other anthropogenic stressors, such as dredging, may have contributed to the low diversity at some of the sites comprising the 30% of low diversity sites not related to sediment or water quality variables (e.g., Coos River, Oregon). At some sites, "natural" stressors may be the primary cause for reduced species richness. For example, intense bioturbation by the burrowing ghost shrimp, *Neotrypaea californiensis*, may have limited species richness in the Salmon River, Oregon, an estuary that receives very few anthropogenic inputs. The large salinity fluctuations that the small, Pacific Northwest river-dominated estuaries can experience over a tidal cycle or following heavy rains may also have contributed to the low species richness at some sites.

Coastal Habitat Index

The coastal habitat index for West Coast estuaries is rated poor. From 1990 to 2000, the West Coast experienced a loss of 1,720 acres of estuarine wetlands (0.54%) (NWI, 2002). The long-term, average decadal loss rate of West Coast wetlands is 3.4%. Averaging these two loss rates results in a coastal habitat index value of 1.90. This is equivalent to a rating of poor. Although the absolute magnitude of the acreage lost for the West Coast was less than that in other regions of the country, the relative percentage of existing wetlands lost was the highest nationally. Western coastal wetlands constitute only 6% of the total estuarine wetland acreage in the conterminous 48 states; thus, any loss will have a proportionately greater impact on this regionally limited resource. Another factor affecting coastal resource condition that is not captured in the wetland loss estimates is the proportion of shoreline that has been altered. The Shore Zone Inventory completed in 2000 for the state of Washington found that almost one-third of all saltwater shorelines in the state had some type of shoreline modification structure, such as bulkhead or rip-rap, in place (Puget Sound Water Quality Action Team, 2002).

Fish Tissue Contaminants Index

Estuarine condition in West Coast estuaries as measured by concentrations of contaminants in fish tissues is rated poor. Figure 6-16 shows that 27% of all sites sampled where fish were caught (72 of 266 sites) exceeded risk-based criteria guidelines using whole-fish contaminant concentrations. (Whole-fish contaminant concentrations can be higher or lower than the concentrations associated with fillets only. Only those contaminants that have an affinity for muscle tissue, e.g., mercury, are likely to have higher fillet concentrations. Fillet contaminant concentrations for most other contaminants will be lower.) For populations that consume whole fish, these risk calculations are appropriate. The contaminants found in fish tissues in West Coast estuaries most often included total PCBs, DDT, and occasionally mercury.

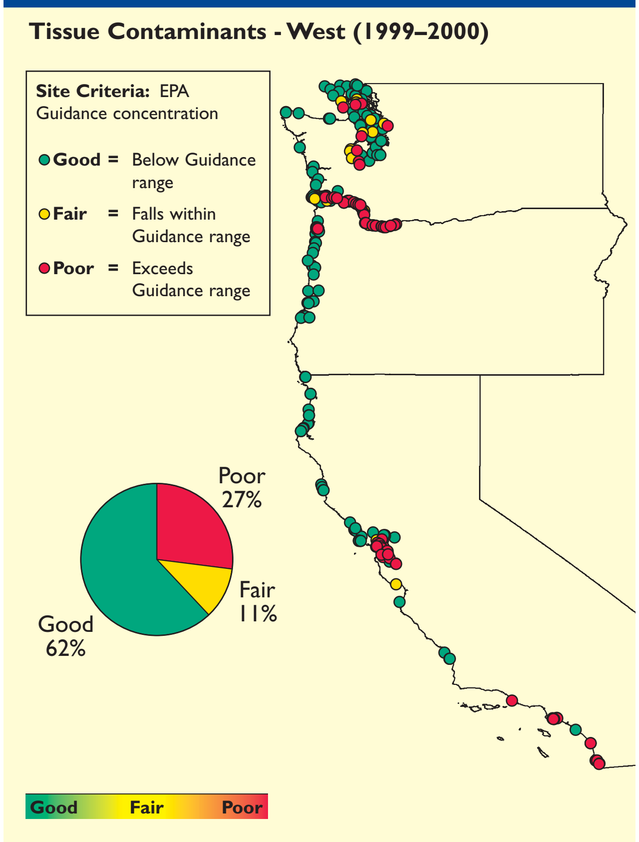


Figure 6-16. Fish tissue contaminants data for West Coast estuaries (U.S. EPA/NCA).

Large Marine Ecosystem Fisheries

Salmon Fisheries

California Current ecosystem salmon support important commercial and recreational fisheries in Washington, Oregon, and California. Salmon are part of the socio-cultural heritage of the region, having been harvested by Native Americans for millennia. California Current ecosystem salmon are anadromous. These fish spawn in fresh water and migrate to the ocean, where they may undergo extensive migrations. At maturity, they return to their home stream to spawn and complete their life cycle. Pacific salmon in the California Current ecosystem include five species: Chinook, coho, sockeye, pink, and chum salmon. Chinook and coho salmon are harvested recreationally and commercially in the Pacific Ocean, Puget Sound, and in freshwater rivers on their spawning migrations. All species are harvested by Native American tribes for subsistence and ceremonial purposes.

During the years 1995 through 1997, the average annual commercial salmon catch was 13,100 mt, providing revenues averaging almost $22 million at dockside. The abundance of individual stocks of California Current ecosystem salmon and the mixture of stocks contributing to fisheries fluctuate considerably. Consequently, the landings of these species fluctuate. For all species, there is excess fishing power and overcapitalization of the fishing fleets. Although harvest rates in recent years have been held near or below levels that would produce a long-term potential yield, environmental conditions have resulted in poor ocean survival of Chinook and coho salmon in general, as well as some individual stocks of other species. Because of the depressed status of many populations of Chinook and coho salmon, these two species are considered overexploited, whereas the other species are considered fully exploited. The management of this resource is complex, involving many stocks originating from various rivers and jurisdictions. Ocean fisheries for Chinook and coho salmon are managed under a Pacific Fishery Management Council (PFMC) FMP, with cooperation from states and tribal fishery agencies. Within Puget Sound and the Columbia River, fisheries for these two species are managed by the states and tribes. The other three species (pink, chum, and sockeye salmon) are managed primarily by the Pacific Salmon

Lighthouses are essential along the rocky California coast (Paul Goetz.)

Commission (PSC), the state of Washington, and tribal fishery agencies.

Fisheries are managed using a variety of regulations. Ocean fisheries are managed primarily by gear restrictions, minimum size limits, and time and area closures, although harvest quotas have been placed on individual fisheries in recent years. The PSC has used harvest quotas, updated on the basis of in-season abundance forecasts. Cumulative impact quotas for weak stocks have been used to regulate some Columbia River commercial fisheries.

Pacific salmon in the California Current ecosystem depend on freshwater habitat for spawning and rearing of juveniles. The quality of freshwater habitat is largely a function of land management practices; therefore, salmon production is heavily influenced by entities not directly involved in the management of fisheries. Salmon management involves the cooperation of the USFS Bureau of Land Management, FWS's Bureau of Reclamation, the USACE, EPA, Bonneville Power Administration, state resource agencies, Native American tribes, municipal utility districts, agricultural water districts, private timber companies, and landowners.

Status reviews have been completed by the NMFS for most species of the California Current ecosystem and have resulted in listings of coho salmon from central California through coastal Oregon; Chinook salmon in California's Central Valley and the upper Columbia and Snake river basins; and sockeye salmon in the Snake River Basin. In March 1999, the NMFS announced the most comprehensive listing decision yet, with final listings of nine evolutionarily significant units (ESUs) of salmon (Chinook, chum, and sockeye) and steelhead trout ranging from the upper Columbia River through Puget Sound. These listings include the metropolitan areas of Portland, Oregon, and Seattle, Washington, that lie within the boundaries of the listed ESUs. Additional information on the status of the five species of Pacific salmon is available in *Our Living Oceans* (NOAA, 1999c).

Pelagic Fisheries

Several stocks of small pelagic fish species support fisheries along the California Current ecosystem. The major species are Pacific sardine, northern anchovy, jack mackerel, chub (Pacific) mackerel, and Pacific herring. Sardine, anchovy, and the two mackerels are primarily concentrated and harvested off California and Baja California. Pacific herring are harvested along the West Coast from California to Washington. Sardine and anchovy are the most prominent of the fisheries from an historical perspective. Population of these small pelagic fish, like Peruvian anchovy and Japanese sardine, tend to fluctuate widely in abundance. California sardines supported the largest fishery in the western hemisphere during the 1930s and early 1940s, when total catches averaged 500,000 mt. Sardine abundance and catches declined after World War II, and the stock finally collapsed in the late 1950s. In the mid 1940s, U.S. processors began canning anchovy as a substitute for sardine; however, consumer demand for canned anchovy was low. In recent years, low prices and market problems continue to prevent a significant U.S. reduction in the fishery for anchovy. The other small pelagic species also have a tendency to fluctuate widely in abundance. All these pelagic fishery resources are currently under management.

Northern anchovy landings in California have fluctuated more in response to market conditions than to stock abundance. Landings in the United States have varied from less than 10,000 mt to nearly 140,000 mt. The well being of ecologically related species in the marine ecosystem is an important factor in management of the anchovy resource. The FMP has specified a threshold for its optimum-yield determination to prevent anchovy depletion and to provide adequate forage for marine fishes, mammals, and birds. More information on the status of pelagic fisheries in the California Current ecosystem is available in *Our Living Oceans* (NOAA, 1999c).

Nearshore Fisheries

Nearshore fishery resources are those coastal and estuarine species found in the 0–3 nautical mile zone of coastal state waters and for which the NMFS has no direct management role. Nearshore resources vary widely in species diversity and abundance. Many are highly-prized gamefish, while others are small fishes used for bait, food, and industrial products. The invertebrate species of greatest interest include crabs, shrimps, abalones, clams, scallops, and oysters. Because the composition of the nearshore fauna is very diverse and management authority is shared among the coastal states and other local bodies, a detailed treatment of the status of these species is difficult. In the California Current ecosystem, California contributes the most commercial landings of nearshore species at an estimated 93,954 mt, followed by Oregon (22,198 mt) and Washington (14,637 mt).

Groundfish Fisheries

Accurate, long-term predictions of potential yield will require a substantial increase in knowledge about competitive and predatory interactions in the biological system of the California Current ecosystem, as well as knowledge about climate effects on this community. The target exploitation rate for most groundfish species is designed to achieve a large fraction of maximum potential yield and reduce the abundance of spawners by about two-thirds (assuming that this will not reduce the mean recruitment level). Only decades of monitoring the stock's performance will ascertain the long-term feasibility of these targets, as well as the degree of natural fluctuation that will occur while maintaining these targets. Unfortunately, there is little historical data on these fluctuations, and the current level of stock assessment data is not adequate to precisely track changes in abundance for more than a few species. In addition, only a low level of effort is directed towards feeding habits studies that may help predict how the interactions among species may change as the abundance of several major species is reduced below unfished levels.

Models of long-term potential yield depend on assumptions of constant average environmental conditions or an ability to predict changing conditions. There is evidence of a decline in zooplankton abundance within the California Cooperative Oceanic Fisheries Investigations' 40-year time series, as well as of an ocean warming during the late 1970s. Dover sole in southern areas, bocaccio rockfish, and lingcod exhibit declines in mean recruitment during this same period. Better understanding of potential linkages between fish recruitment and long-term changes in the ocean climate are integral to improving the 5- to 10-year forecasts of potential fishery yield.

EMAP 2002 – West Coast Intertidal Wetlands Condition Assessment

Much of the West Coast of the United States is subject to large tidal fluctuations, resulting in extensive intertidal flats that are sometimes equal to 50% or more of the total estuarine area. Because such fluctuations are important to many West Coast estuaries, EMAP conducted a pilot assessment of the condition of estuarine tidelands from Puget Sound to the Mexican border in 2002. In addition to this regional assessment, localized studies in San Francisco Bay and Southern California focused on development of a range of condition indicators for low salt marsh habitats. These assessments of intertidal wetlands (vegetated and unvegetated habitat between mean low water and mean high water) complement the previous EMAP subtidal assessments conducted between 1999 and 2000, resulting in a more complete picture of estuarine condition on the West Coast.

The intertidal sample design included 61 sites in Washington, 67 sites in Oregon, and 90 sites in California. In California, 30 sites were randomly allocated along the coastline, with another 30 sites randomly allocated within each of the two pilot-study regions. A series of indicators suitable for intertidal habitats, including a variety of plant community indicators (Table 1), were sampled at all sites in the three states. Additional indicators were measured at the two intensive studies in Southern California (Point Conception to the Mexican border) and San Francisco Bay (Table 2). This monitoring design provides both a statewide assessment of intertidal wetland conditions and independent assessments of Southern California and San Francisco Bay wetlands.

Table 1. Environmental Condition Indicators Used for the 2002 Intertidal Wetlands Assessment Study (U.S. EPA, NCA).

- Tidal water temperature, depth, salinity
- Sediment pore water salinity
- Sediment bulk density
- Sediment percent TOC
- Sediment grain size
- Sediment inorganic contaminants
- Sediment organic contaminants
- Sediment percent nitrogen
- Sediment percent phosphorus
- Infaunal species composition
- Infaunal abundance
- Infaunal species richness and diversity
- Emergent macrophyte species richness
- Emergent macrophyte species diversity
- Emergent macrophyte species maximum stem or shoot length
- Percent of macrophyte species as nonindigenous species
- Submerged aquatic vegetation or macroalgal percent cover
- Submerged aquatic vegetation maximum shoot length

The pilot studies in Southern California and San Francisco Bay provided the opportunity to broaden the focus of the International Wetlands Asssessment Study beyond an emphasis on sediment contamination and water quality to include issues specific to intertidal wetland habitats, such as habitat fragmentation, threatened and endangered native species, the spread of nonindigenous species, the modification of tidal flushing, and the impacts of land use alteration on wetlands (Table 2). Inclusion of these landscape and ecosystem-scale indicators should generate a more complete and accurate assessment of the effects of stressors on West Coast estuaries.

Table 2. Environmental Condition Indicators Used in the San Francisco Bay and Southern California 2002 Intertidal Wetlands Assessment Study (U.S. EPA, NCA).

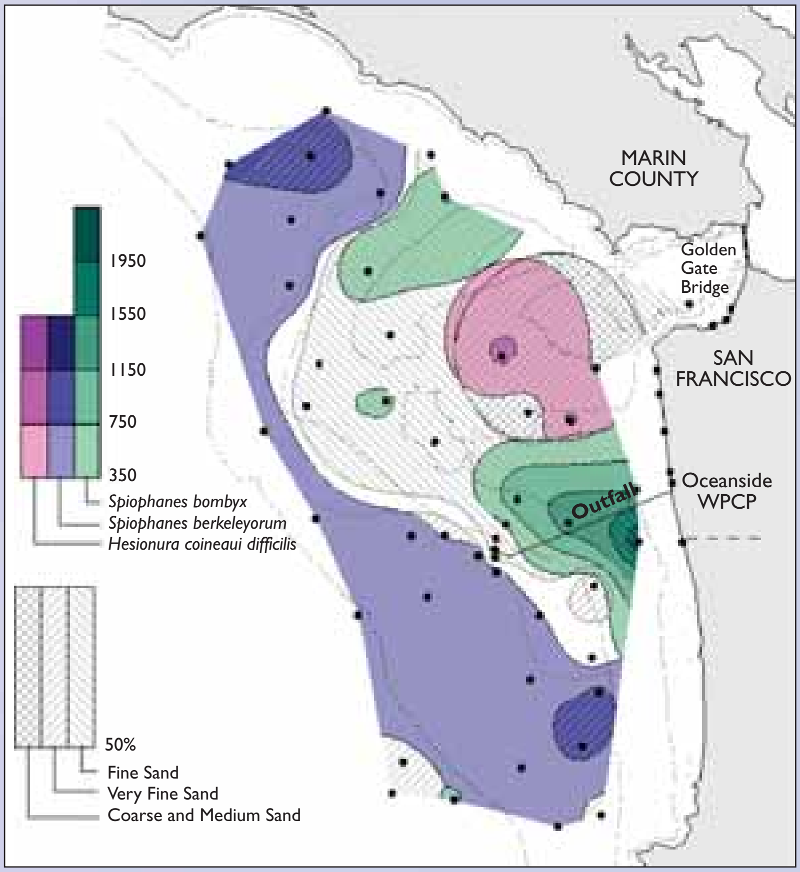
- Plant community composition and percent cover for drainage system
- Wrack line trash composition for drainage system
- Nonindigenous species plants for habitat patch
- Management objectives for habitat patch
- Number of recreational facilities and annual visitors for habitat patch
- Presence of man-made water control structures and levees
- Total annual POTW, industrial, and power plant discharges to wetland watersheds
- Human population density for watershed
- Human population age structure for watershed
- Habitat connectivity of tidal marsh patches
- Percent attenuation of spring tide range
- Intertidal channel density for habitat patch
- Total acreage for habitat patch
- Total perimeter for habitat patch
- Shoreline development index for habitat patch
- Shape index for habitat patch
- Adjacent land cover for habitat patch
- Size class distribution for all habitat patches

City and County of San Francisco Offshore Monitoring Program

The city and county of San Francisco conduct a regional monitoring program offshore of the mouth of San Francisco Bay. San Francisco's combined sewer system collects all sanitary and industrial wastes and stormwater runoff for treatment to primary or secondary standards prior to being discharged to the ocean. Activities from the highly urbanized Bay Area and agricultural Central Valley affect the environmental quality of San Francisco Bay waters, which pass through the study area with each tidal cycle. The program includes bacterial monitoring at beaches to provide public health data and to determine impacts from shoreline discharges. Additionally, offshore monitoring is conducted to evaluate the impacts of treated wastewater discharges on sediments and marine life.

Total coliform bacteria concentrations, an indicator for water-borne pathogens that could cause illness to those involved in beach recreation, are generally low year round, with increases correlating to rainfall and shoreline discharges. Surveys documented beach recreation as low during or following shoreline discharges, which typically occur during severe storm events in midwinter. Beach warnings are posted whenever a shoreline discharge occurs or when bacteria counts are elevated. Beach water quality information and the 5-year summary report (1997–2001) of offshore monitoring data are available on the city's Web site (http://www.sfwater.org). Water quality information is also available on a toll free hotline (1-877-SF BEACH) and at EPA's national Web site (http://www.earth911.org).

Bottom fish and sediment-dwelling benthic invertebrates present in the study area represent species common in central California's nearshore, sand-bottom environments. Sediment grain size is the primary factor influencing the composition of species that live in the sediments. Some outfall stations showed an increase in abundance of these species compared to some reference stations, suggestive of enrichment; however, a comparison of abundance of species living in the sediment at outfalls and reference sites spanning the periods before and after wastewater discharge demonstrated no significant difference. Mean grain sizes at the outfalls have not changed significantly since predischarge and preconstruction periods, suggesting that the wastewater discharge has not affected sediment grain size distribution.



Sediment grain size and species composition of benthic invertebrates near oceanside discharge outfall.

Bioaccumulation of pollutants measured in the tissues of English sole and Dungeness crab are not significantly different between reference and outfall regions. Pollutant levels are higher in fatty tissues (fish liver and crab hepatopancreas) than in muscle tissue. Pollutant levels measured in sediments did not appear to affect pollutant tissue levels in organisms from the study area.

Additional information can be obtained by contacting Michael Kellogg at (415) 242-2218 or mkellogg@sfwater.org.

Assessment and Advisory Data

Clean Water Act Section 305(b) Assessments

The West Coast states assessed 4,990 (95%) of their 5,249 estuarine square miles for their 2000 305(b) reports (total area of estuaries presented in the states' 305(b) reports differs significantly from that determined from the NCA survey). Of the assessed estuarine square miles on the West Coast, 13% fully support their designated uses, less than 1% are threatened for one or more uses, and almost 87% are impaired by some form of pollution or habitat degradation (Figure 6-17 and Table 6-1). Individual use support for the West Coast estuaries is shown in Figure 6-18.

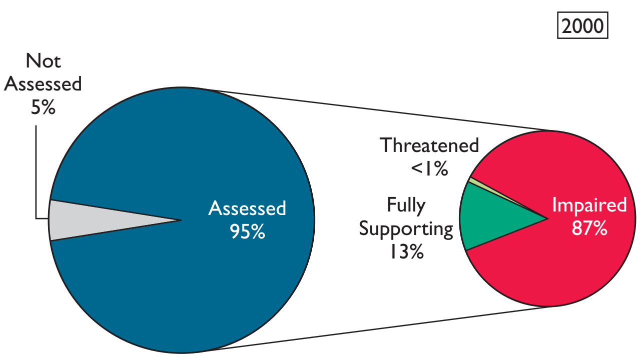


Figure 6-17. Water quality in assessed West Coast estuaries (U.S. EPA, 2002).

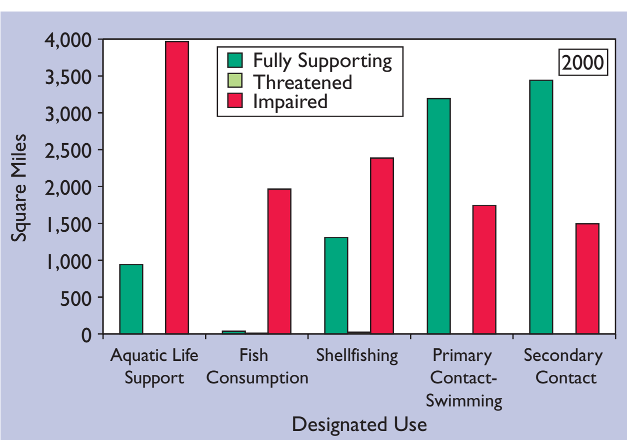


Figure 6-18. Individual use support in assessed West Coast estuaries (U.S. EPA, 2002).

The West Coast states assessed 997 (47%) of their 2,134 shoreline miles. Seventy-eight percent of the assessed shoreline miles fully support their designated uses, no shoreline miles are reported as being threatened, and 22% of the assessed shoreline is impaired by some form of pollution or habitat degradation (Figure 6-19). Individual use support for West Coast shoreline miles is shown in Figure 6-20.

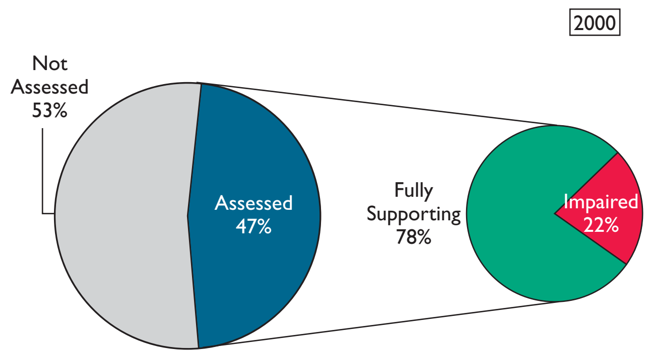


Figure 6-19. Water quality in assessed shoreline waters in the West Coast region (U.S. EPA, 2002).

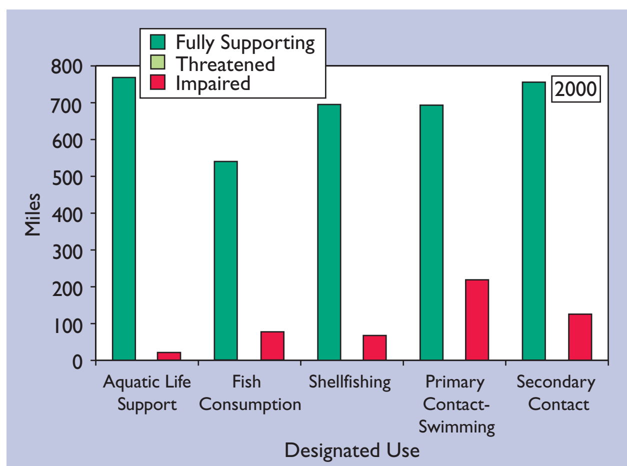


Figure 6-20. Individual use support for assessed shoreline waters in the West Coast region (U.S. EPA, 2002).

Table 6-1. Individual Use Support for Assessed Coastal Waters Reported by the States on the West Coast under Section 305(b) of the Clean Water Act. (Percent impaired is based on the total area assessed for each individual use.) (U.S. EPA, 2002).

Individual Uses	Assessed Estuaries Impaired (mi^2)	Assessed Shoreline Impaired (mi)
Aquatic life support	3,976 (81%)	21 (3%)
Fish consumption	1,974 (97%)	77 (13%)
Shellfishing	2,395 (64%)	66 (9%)
Primary contact – swimming	1,740 (35%)	218 (24%)
Secondary contact	1,501 (30%)	127 (14%)

Fish Consumption Advisories

In 2002, 24 fish consumption advisories were in effect for the estuarine and coastal waters of the West Coast (Figure 6-21). A total of 21% of the estuarine square miles of the West Coast were under advisory in 2002, and all of the estuarine area under advisory was located within the San Francisco Bay/Delta region or within Puget Sound. Only 11% of the coastal miles were under advisory; more than one-half of these miles were located in Southern California, and the rest were located on coastal shoreline in Washington's Puget Sound. None of the West Coast states (California, Oregon, or Washington) had statewide coastal advisories in effect in 2002. Although Oregon did not list any fish consumption advisories for estuarine or coastal waters in 2002, there is a fish consumption advisory for the lower Columbia River (which forms the border between Washington and Oregon) issued by Washington State for all species for PCBs, dioxins/furans, and DDT.

Seventeen different contaminants or groups of contaminants were responsible for West Coast fish advisories in 2002, and 14 of those contaminants were listed only in the waters of Puget Sound and bays emptying into the sound (arsenic, chlorinated pesticides, creosote, dioxin, industrial and municipal discharge, metals, multiple contaminants, PAHs, PCBs, pentachlorophenol, pesticides, tetrachloroethylene, vinyl chloride, and volatile organic compounds [VOCs]). In California and Washington, PCBs were partly responsible for 67% of advisories (Figure 6-22). DDT was partly responsible for 12 advisories issued in California. Although there were only two advisories issued for mercury on the West Coast, the entire San Francisco Estuary was covered by one of these advisories.

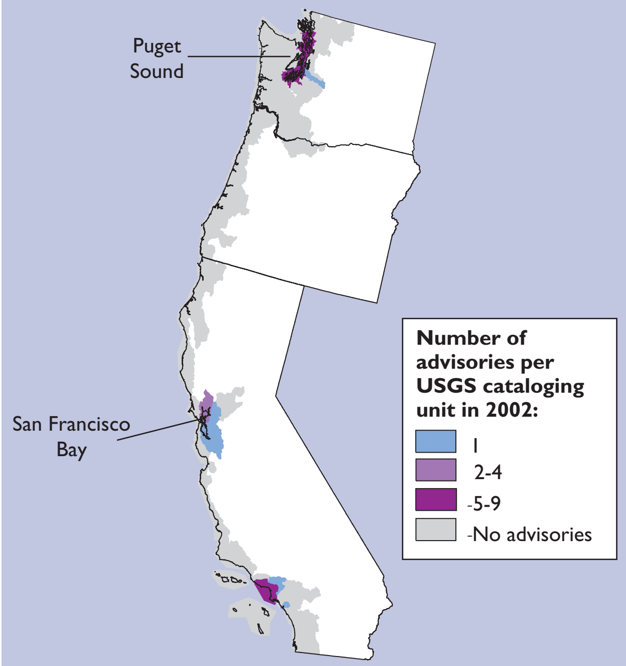


Figure 6-21. The number of fish consumption advisories per USGS cataloging unit for the West Coast (U.S. EPA, 2003c).

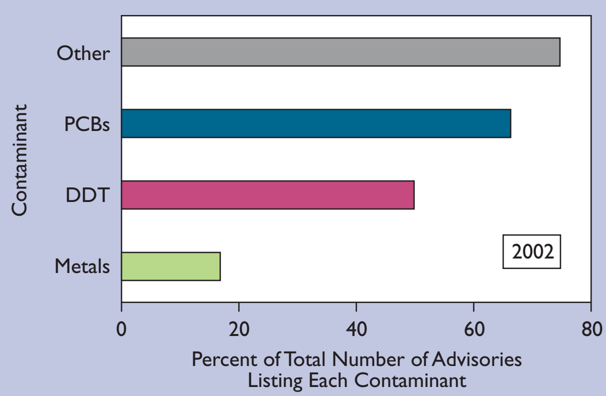


Figure 6-22. Contaminants responsible for fish consumption advisories in the waters of the West Coast in 2002. An advisory can be issued for more than one contaminant, so percentages may not add up to 100 (U.S. EPA, 2003c).

The following fish and shellfish species were under advisory in at least some part of the coastal waters of the West Coast in 2002:

Black croaker	Queenfish
Bivalves	Rockfish
Bullhead	Sculpin
Clams	Shark
Corbina	Shellfish
Crab	Striped bass
Gobies	Surfperch
Kelp bass	White croaker

Source: U.S. EPA, 2003c

Beach Advisories and Closures

Of the 274 coastal beaches in the West Coast region that reported information to EPA, 65% (178 beaches) were closed or under an advisory for some period of time in 2002. Table 6-2 presents the numbers of beaches, advisories, and closures for each state. California had the most beaches responding to the EPA survey (269), as well as the most advisories and closures. It should be noted, however, that the total number of beach advisories and closures may not be indicative of increased health risks to swimmers, but is generally indicative of more intensive bacterial sampling efforts conducted at the surveyed beaches. In 2002, only five beaches in Washington provided a survey response, and no beaches in Oregon completed the EPA BEACH survey. Figure 6-23 presents advisory and closure percentages for each county within each state.

Most beaches had multiple sources of water-borne bacteria that resulted in advisories or closures. Unknown sources accounted for 74 percent of the responses from West Coast beaches (Figure 6-24).

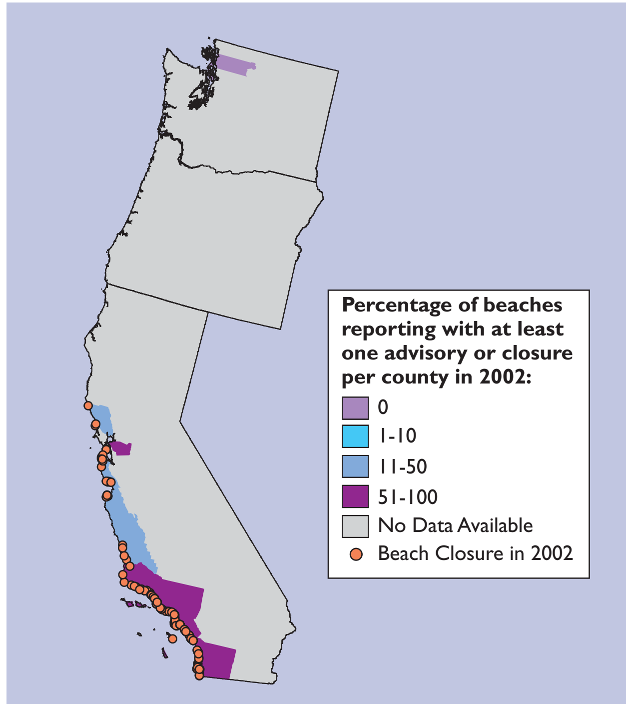


Figure 6-23. Percentage of West Coast beaches with advisories or closures by county in 2002 (U.S. EPA, 2003a).

Table 6-2. Number of Beaches and Coastal Advisories/Closures in 2002 for the West Coast.

State	No. of Beaches	No. of Advisories/ Closures	Percentage of Beaches Affected by Advisories/ Closures
California	269	178	66.2 %
Oregon	-	-	-
Washington	5	0	0.0%
TOTALS	274	178	65.0 %

Source U.S. EPA, 2003a

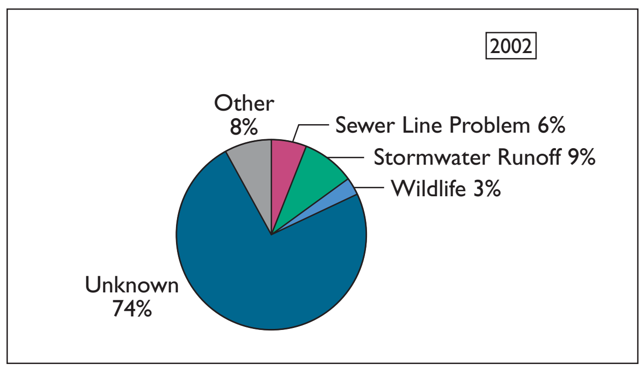


Figure 6-24. Sources of beach contamination in the West Coast region (U.S. EPA, 2003a).

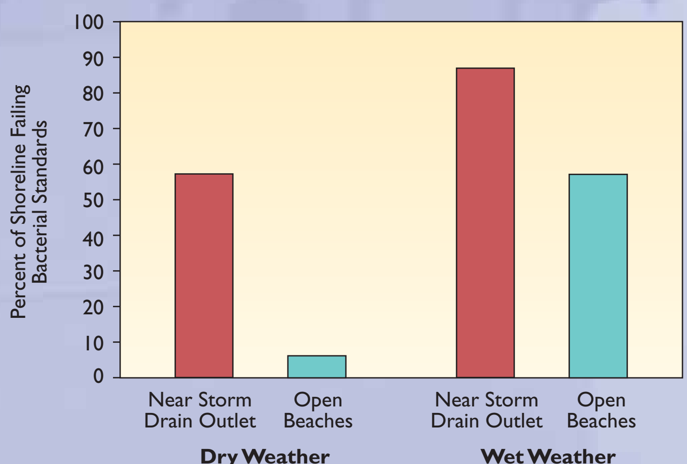
Clamming season opens on the Oregon coast west of Astoria (Commander Grady Tuell, NOAA Corps).

Southern California's Beach Water Quality

Southern California beaches are a valuable recreational resource, receiving more than 300 million visitors and contributing 9 billion dollars to the local economy annually. Southern California beaches are also the most extensively monitored in the country, with most supervision focused on known problem areas. To better assess overall shoreline water quality, 22 organizations that monitor bacteriological levels along the Southern California shoreline coordinated their efforts to conduct three integrated coastline surveys. Two of the surveys were conducted during dry periods, and one was conducted following a rainfall event.

Multiple bacterial indicators (e.g., total coliforms, fecal coliforms, and enterococci) were collected from nearly 300 beach sites, randomly selected using a stratified sampling design. Water quality along coastal beaches was consistently good during dry weather, with almost 95% of the shoreline sites meeting bacterial standards. The few open coastline samples that exceeded bacterial standards were barely above guidelines and surpassed standards for only one of the three bacterial indicators measured. In contrast, nearly 60% of the beaches near urban runoff outlets (storm drains) failed water quality standards, with most of the samples failing for multiple bacterial indicators. Effects of land-based runoff were more exaggerated during wet weather, when 58% of the open coastline and 87% of the beaches near storm drains failed water quality standards. The levels of these water quality standard failures were also much higher in wet weather.

Results of this study have served to reassure visitors that beach water quality monitoring programs currently being conducted at Southern California's beaches are highly effective. Management efforts are focused on improving urban runoff quality, with warnings not to swim near runoff outlets currently issued for three days following storm events.



Source: Noble et. al., 2003

Summary

The Golden Gate Bridge as seen from atop NOAA's Gulf of the Farallones National Marine Sanctuary Office at the Presidio, San Francisco, California (Rich Bourgerie, Oceanographer, CO-OPS, NOS, NOAA).

Based on the indices used in this report, ecological conditions in West Coast estuaries are considered fair. These results are largely driven by results from Puget Sound and the San Francisco Estuary; most smaller systems along the coast are estimated to be in better condition. The NCA 1999–2000 data confirm the conclusion of the NCCR I that the primary problems in West Coast estuaries are degraded sediment quality. The NCA data show that 21% of estuarine sediments exceed ERL/ERM guidelines for sediment contaminants. For most of the West Coast estuarine area, sediment contamination was due to exceedance of ERLs for multiple compounds rather than for a single compound exceeding the ERM value. There was little indication of elevated levels of organic matter in the sediments, and although there was evidence of sediment toxicity from amphipod bioassays, in some cases toxicity was not explained by measured contaminants at a site. Dissolved oxygen, chlorophyll *a* concentrations, and levels of nitrogen are considered good for West Coast estuaries, except in some isolated regions of Puget Sound. Based on the water clarity indicator, considerable areas of West Coast estuaries have poor light penetration, but the high tidal amplitude in much of the region may require a reevaluation of the threshold levels used for this indicator in the West. Increasing population pressures (particularly in the Seattle-Tacoma region, the San Francisco Estuary, and Southern California) require continued environmental awareness and programs to correct existing problems and to ensure that environmental indicators currently in fair condition do not worsen and become poor.